Title: Math Through The Ages - A Study of Patterns in Number Systems

Link to Outcomes:

- **Problem Solving** Students will demonstrate their ability to use problem solving to identify patterns in various number systems.

- **Communication** Students will use reading and language skills to analyze the structure of number systems.

- **Reasoning** Students will use mathematical reasoning skills to interpret, compare, and analyze.

- **Connections** Students will compare the structure of mathematics in societies throughout the ages.

- **Number Systems** Students will extend their understanding of the relationships of **& Theory** numbers within a number system.

- **Computation** Students will compute whole numbers within the structure of varying number systems.

- **Patterns** Students will identify the patterns within a number system and the **& Functions** patterns among number systems.

Brief Overview:

This activity is the study of a variety of number systems. Students will research the background of number systems and the societies from which they came. They will share this information with classmates using the cooperative learning strategy jigsaw. Students will extend their knowledge and understanding of each number system through activities using each and identify patterns within each system. They will then apply this knowledge to the structure of our own system. They will identify the characteristic and patterns that make up a number system and use this knowledge to develop one of their own.

Grade/Level:

Grade 5-6 (This could be used by Grade 4 gifted students.)

Duration/Length:

This unit includes 6 activities which may be used on consecutive or non-consecutive days at the teacher's discretion.

Prerequisite Knowledge:

- The student should understand basic concepts of mathematics.

Objectives:

- The students will research number systems using *jigsaw*.
- The students will identify characteristics of a number system.
- The students will establish patterns within and among systems.
- The students will develop a number system.

Materials/Resources/Printed Materials:

- Reference books
- Resource sheets
- Egyptian symbol cards
- Toothpicks
- Counting chips
- Index Cards

Development/Procedures:

Activity 1 The students will research the backgrounds of societies and their respective number systems.

- Introduce concepts of differences in societies throughout history using pictures of clothing, housing, transportation, and customs from a variety of different groups making sure to include societies from all areas of the world.
- Group students into three research teams. Distribute to each student a copy of resource sheet "Civilization Fact Find" (Student Resource #1). Assign each team a culture, Egyptian, Mayan, or Roman.
- Assign each member of the team a different focus area of the society. Following the procedures for the cooperative learning strategy *jigsaw*, combine focus area groups for research.
- Ask culture teams to reassemble and fill out their "Fact Find."
- Ask one student for each culture to form a group of three to share their findings.
- Reconvene whole class and discuss patterns within societies.

Activity 2 The student will apply knowledge of Egyptian number system to actual use.

- Review basics of Egyptian number system from previous activity.
- Pair students and distribute one set of Egyptian symbol cards to each pair.
- Write several numbers on the board and have students convert them to Egyptian numbers using the Egyptian cards. (See Egyptian Card Resource Sheet (Student Resource #2) and Math Systems Data Sheet (Student Resource #3) for ideas.)
- Present examples of addition and subtraction problems using Egyptian numerals and ask students to write samples and share them with classmates.
- Ask students to complete resource sheet "Egyptian Numbers" (Student Resource #4).
- Discuss with students the rules and patterns that create this system.
- Ask students to create the fifth, sixth and seventh symbols in the system. Ask them to write a paragraph explaining why they made their choices.
  (Exemplar response might include the idea of creating a symbol based on the life style within the culture.

Activity 3   The student will apply knowledge of Roman number system to actual use.

- Review basics of Roman number system from initial activity.
- Elicit from students the rules of the system identifying existing patterns (See Math Systems Data Sheet (Student Resource #3) for ideas).
- Take 50 index cards and write a variety of Roman numerals, depending on the level of students, on 25 cards. Write the corresponding Hindu/Arabic numeral on the other twenty-five. Modify number of cards to accommodate number of students in class.
- Distribute cards randomly. Ask students to walk around silently and find match.
- Ask students to complete resource sheet "Wish You Were Here" (Student Resource #4).

Activity 4   The student will apply knowledge of Mayan number system to actual use.

- Review basics of Mayan number system from initial activity. (Depending on the level of students; one, two or three place values may be used.)
- Distribute toothpicks and counting chips to each student. Pretzel sticks and raisins may also be used.
- Write several numbers on the board and ask students to convert them to Mayan numbers using the manipulatives (See Math Systems Data Sheet (Student Resource #3) for ideas).
- Discuss with students the rules and patterns that create this system.
- Discuss with students that the Mayans introduced the concept of zero and ask students to write a paragraph on the importance of zero in our number system.
  (Exemplar response should include the concept of zero as a placeholder.)

Activity   5   The students will identify characteristics and patterns of the Hindu/Arabic number system and compare and contrast those characteristics to the number systems previously studied.

- Elicit from students the characteristics of our number system and record on web. See "Sample Web" resource sheet (Students Resource #5).
- Ask students to create a table using the resource sheet "How Do They Compare" (Student Resource #6) to compare and contrast the four systems.
- Elicit from students what characteristics make up a number system.
  (Responses should include - use of symbols, rules for usage, possible place value, and patterns.)

Activity 6   The students will develop their own number system.

- Review chart "How Do They Compare" from **Activity 5**.
- Ask students to complete the resource sheet "My Own Number System" (Student Resource #7).
  (Note: When students complete this sheet, make a copy of it for them to record answers to problems.)
- Ask students to give their worksheet to a partner to complete the following class period.
- Ask partners to meet to discuss the strengths and weaknesses of their systems.
- Reconvene whole class, and discuss what patterns each student used to develop his/her system.

Evaluation:

Students can be evaluated based on the following criteria:

- Group participation and performance
- Teacher observation of class activities
- Completed resource sheets
- Writing assignments (see exemplar responses)
- Final project (check for establishment of logical set of rules and patterns)

Extension/Follow Up:

- The class may continue the study to include more civilizations.
- As an art extension, students may investigate the art of the specific societies and look for patterns.
- As a social study extension, students might create a time line of the civilizations.

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CIVILIZATION FACT FIND

1. Name of civilization:

2. Area of world found:

3. Time period in history:

4. Clothing description:

5. Housing:

6. Language:

7. Transportation:

8. Number system: On the reverse side of this paper describe this society's number system with regard to:

    - symbols
    - rules
    - patterns

EGYPTIAN NUMERAL CARDS

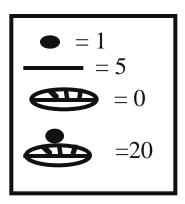|			
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MATH SYSTEMS DATA SHEET

EGYPTIAN: The initial Egyptian numeration system is based on tally marks. They then developed a grouping system. In this system, a different symbol was used to represent specific sets of numbers. The Egyptians chose symbols from their environment.

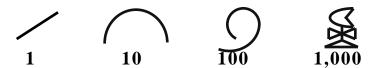| Symbol	Name	Value
╱	vertical staff	1
∩	heel bone	10
ට	scroll	100
⚑	lotus flower	1,000
☞	pointing finger	10,000
⋈	polliwog	100,000
⚲	astonished man	1,000,00

MATH SYSTEMS DATA SHEET

MAYAN: The Mayan numeration system is a base 20 system. It uses 3 symbols. The numbers are written vertically with the greatest place value on top. The first level has a place value of 1, the second level has a place value of 20 and the third has a place value of 360. The Mayans were the first to use a zero in their number system.

● = 1

——— = 5

= 0

=20

= 17

= 21

1 TWENTY

1 ONE

EGYPTIAN NUMBER SYSTEM

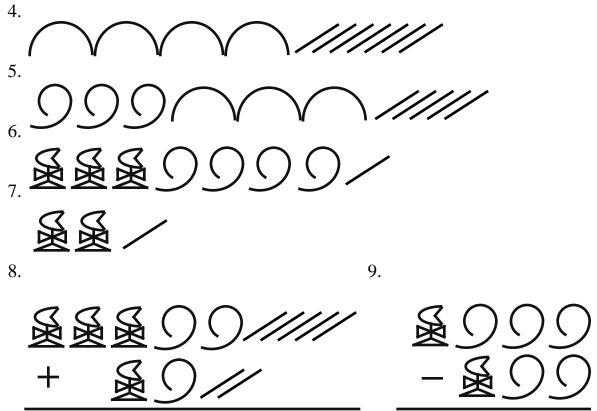| /	◠	୨	৪
1	**10**	**100**	**1,000**

Write these numbers as the Egyptians would have.

1. 999

2. 1892

3. 6943

Write these Egyptian numbers in Hindu/Arabic numbers.

4.

5.

6.

7.

8.   9.

                                                    +

10.   Write your birth date using Egyptian numerals.

"WISH YOU WERE HERE"

Sally is really enjoying her vacation in Rome — Can you tell? Help translate her postcard for her folks.

Dear Mom & Dad,
    It is July XXIX, MCMXCV, I am on the XIVth day of my vacation. It has been very hot. The temperature was XCIV today. I am really enjoying myself. Gotta go! Must catch my train at XXII : LIX. See you on VII/ XXXI/ XCV. Wish you were here.
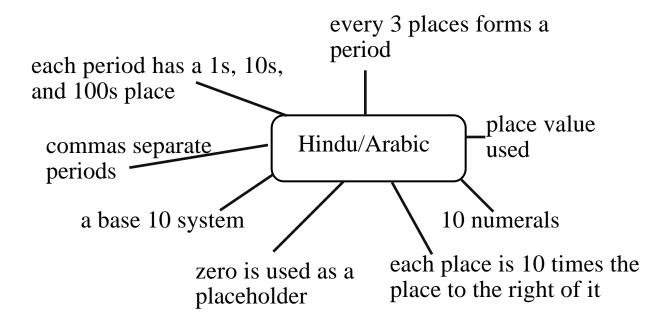<div align="right">Love,
Sally</div>

32

Air Mail

Mom & Dad Smith
My House
My Town, My State
12345

Write a message, like Sally's, using Roman numerals.

CHARACTERISTICS OF OUR NUMBER SYSTEM

Below is a simple web that would be the outcome of Activity 5.

every 3 places forms a period

each period has a 1s, 10s, and 100s place

place value used

commas separate periods

Hindu/Arabic

a base 10 system

10 numerals

zero is used as a placeholder

each place is 10 times the place to the right of it

HOW DO THEY COMPARE?

System	Place value (Y/N)	Numerals/ Symbols (N/S)	Vertical/ Horizontal (V/H)	Zero (Y/N)	Base Number
Egyptian					
Roman					
Mayan					
Hindu/ Arabic					

Similarities:

Differences:

MY OWN NUMBER SYSTEM

System	Place value (Y/N)	Numerals/ Symbols (N/S)	Vertical/ Horizontal (V/H)	Zero (Y/N)	Base Number

Use these headings to help you develop the rules and patterns for your system. Display the symbols and/or numbers your system uses, and list any important rules. Under that, have five problems converting your numbers to Hindu/Arabic and five problems doing the reverse. If time allows, include some addition and subtraction problems.

RESOURCES

A Problem Solving Approach to Mathematics for Elementary School Teachers by Rick Billstein, Shlomo Libeskind, and Johnny Lott, Addison Wesley, 1993.

Curriculinks (5-6) by Christy Fong, Creative Publications, 1995.

Mathematical History by Merle Mitchell, NCTM Publications, 1978.

Multicultural Mathematics Materials by Marina C. Krause, NCTM Publications, 1983.